Space Weather Technical Forecast

Issued on Thursday, 23 May 2024 at 13:03 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1 Likely throughout. Slight Chance G1, peak risk Saturday 25 May. Up to two potential CMEs awaiting imagery for assessment.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate at GOES16, with occasional M-class flares observed. All of these emanated from AR3679 in the southwest quadrant, peaking with an impulsive M4.2 at 23/0216UTC.

AR3679 is one of up to six sunspot regions on the current disc, with AR3674 having become indistinct on the southwest limb in the 24 hours as an unnumbered region appeared in the northwest. Changes in the visible sunspot groups were generally small in the period, however the main exception was in AR3679 in the southwest, which saw emergence and spreading of new central penumbral spots to become a compact group, an Ehc/Beta-Gamma-Delta in the latest analysis. AR3685 is also of note given its position near centre-disc, however changes were minor and generally in small movements of peripheral spots, although a Mt Wilson delta potentially remains in the south.

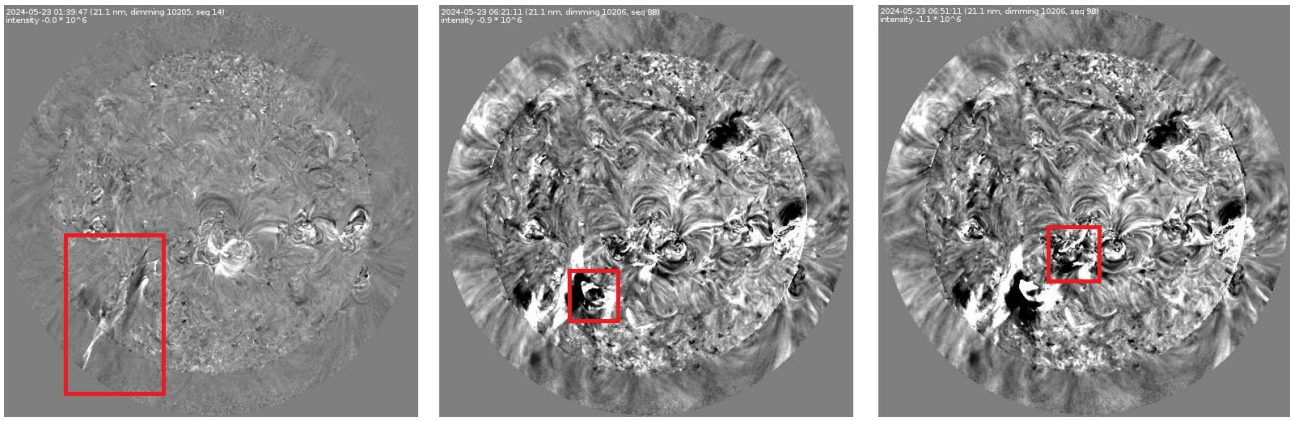

Figure 0: SIDC ROB-processed time-integrated AIA211 dimmings of three possible CME-generating events of note in the past 24 hours, with each event shown boxed in red at 23/0140UTC, 23/0600UTC and 23/0630UTC. Only the first of these has been assessed fully at the time of writing (as a miss).

The period has been notably active in terms of Coronal Mass Ejections (CMEs). At the time of writing, the main CMEs of note include a very large partial filament lift off near 30 East, with the centroid difficult to determine, but producing a filament channel-like signature in AIA304 near 30S around 23/0100UTC. The expanding channel in turn helped trigger a second event near S25E020 around 23/0600UTC, which in turn may have been the catalyst to trigger a more central filament eruption at 23/0630UTC, with this final event clear on AIA304 and H-Alpha imagery.

The lift-off locations are progressively more noteworthy from this trio, getting nearer and nearer centre-disc with each event. However, coronagraph imagery is not yet available in sufficient

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quantity/quality to assess anything other than the initial 23/0100UTC filament, with this determined to miss, crossing 1AU late on 26 May. The later two CMEs are therefore pending assessment - the latest imagery suggests one or both of these is mainly southeast-directed, with some form of weak ejecta visible between 11 and 6 o'clock (plane of sky).

Honourable mentions also include a messy, slightly south-shifted far-sided halo around 22/1800UTC, with no effect felt at Earth (in terms of solar radiation, as with the front-sided events to date).

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 have been indicative of ongoing slow wind conditions.

The solar wind speed showed a slow upward trend in the 24 hours within Background levels, rising from 350 to 400km/s. The solar wind density was level and at Background in single-figures ppcc. The IMF was erratic in magnitude but within Background, peaking at 9nT, with a north-south component ranging between an initially co-aligned (with Earth's field) period with a peak of +8nT, falling to a nadir of -6 into the current UTC morning. The phi angle was erratic but within positive territory throughout (away from the Sun).

The net result of the above solar wind measures was provisionally Quiet geomagnetic indices throughout.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 (greater than 10 MeV) remained at Background levels.

High energy electron flux (greater than 2MeV) observed by GOES16 was mainly Moderate, with a broad peak near 250pfu in the UTC afternoon and early evening of 22 May. The associated 24-hour fluence has remained below the Active threshold, with a decreasing then level trend. Observed fluence at 23/0001UTC was 7.12e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely to continue, with isolated M-class flares possible each day, and a Slight Chance of rising to High due to any X-class flares. These are most likely from AR3679. Ex-AR3663 and Ex-AR3666 are also anticipated to return to the northeast limb into the UTC weekend, however, it is uncertain how much of these regions have survived their transit across the far-side and the overall risk is gradually downward over the four-day period as a result.

Solar Wind / Geomagnetic Activity: At the time of writing there are no Earth-directed CMEs expected, with up to two awaiting imagery (discussed in Solar Activity section).

Slightly Elevated solar winds are expected to persist today and tomorrow (23-24 May), before the onset of any fast wind enhancement from the southward extension of northern hemisphere CH39/-. The strength and timing of this enhancement is low confidence, but there is perhaps a peak risk of a Slight Chance of G1, perhaps most likely Saturday 25 May, with activity otherwise starting and ending the four days Quiet (barring any new CMEs).

Energetic Particles / Solar Radiation: High energy proton flux carries a daily Slight Chance of enhancement should any upper-end Moderate or Strong flares materialise. This may begin to very gradually reduce later in the UTC weekend as the larger spot groups recede.

High energy electron flux is forecast to remain at Normal Background to Moderate levels initially, perhaps attenuating at GEO in any fast wind into the UTC weekend before an uncertain but probably low-magnitude recovery into the new UTC week.

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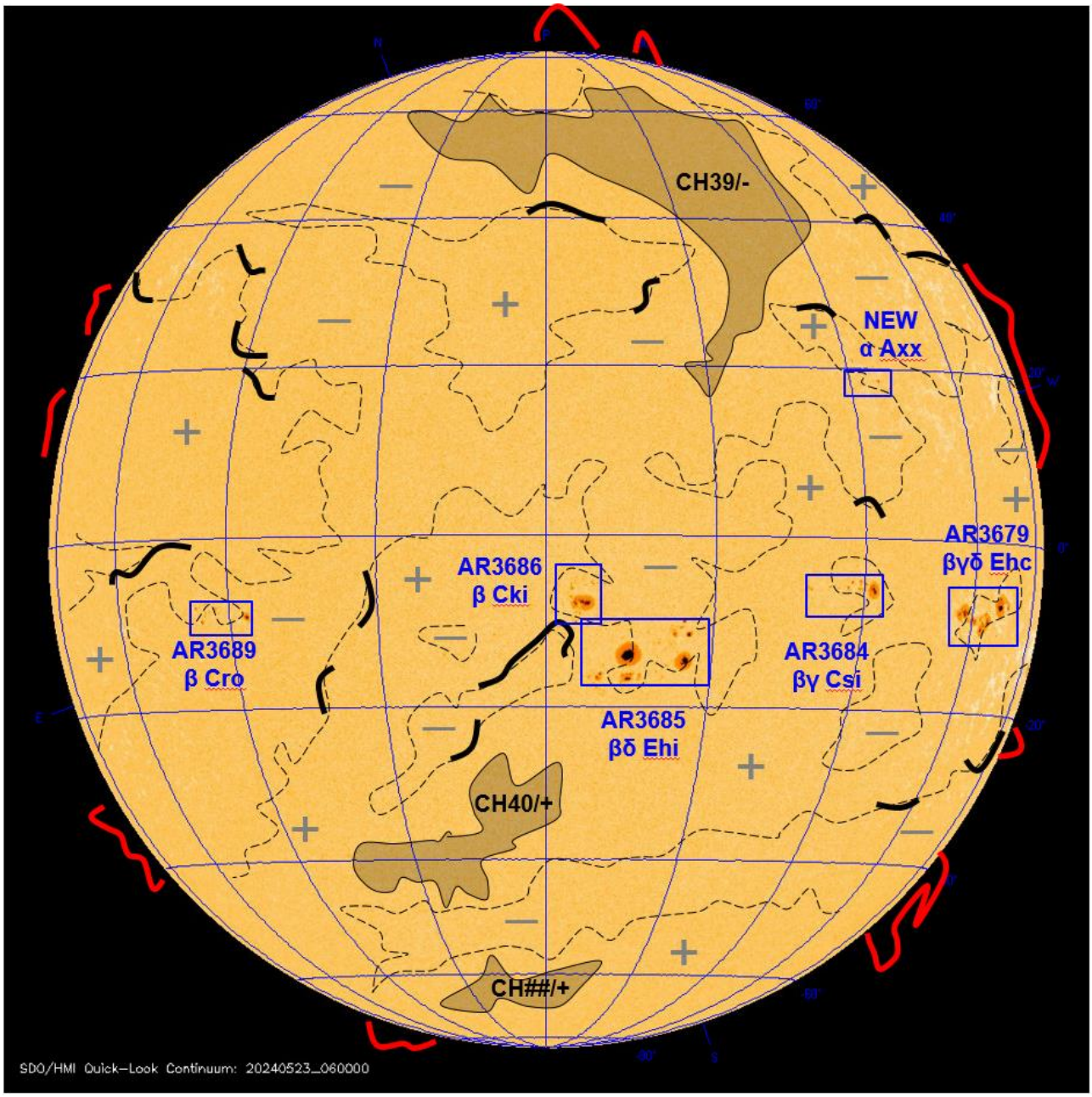
Figure 1. Solar Analysis Valid 23/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

At the time of writing there are no Earth-directed CMEs expected, with up to two awaiting imagery (discussed in Solar Activity section). The forecast therefore comprises non-persistent coronal hole influence and is most likely low confidence but low impact (any CMEs excepted).

Slightly Elevated solar winds are expected to persist today and tomorrow (23-24 May), before the onset of any fast wind enhancement from the southward extension of northern hemisphere CH39/-. This is a large northern hemisphere feature, with a narrow southern extension into the solar mid-latitudes, and was not present on the previous rotation. Coupled with the un-favoured time of year for strong connections to coronal hole fast winds (Russel-McPherron effect), and the limited response currently featured in the MOSWOC Enlil model, a significant geomagnetic response is considered unlikely.

Any fast wind enhancement is likely to reach roughly 450-500km/s, with Active geomagnetic intervals possible from late tomorrow (Friday 24 May), with a peak risk of a Slight Chance of G1/Minor geomagnetic storms Saturday 25 May.

Mainly Quiet conditions should otherwise start and end the forecast period, although note the unassessed CMEs which may well chance the UTC weekend forecast.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Currently nil, but up to two unassessed candidates pending imagery.

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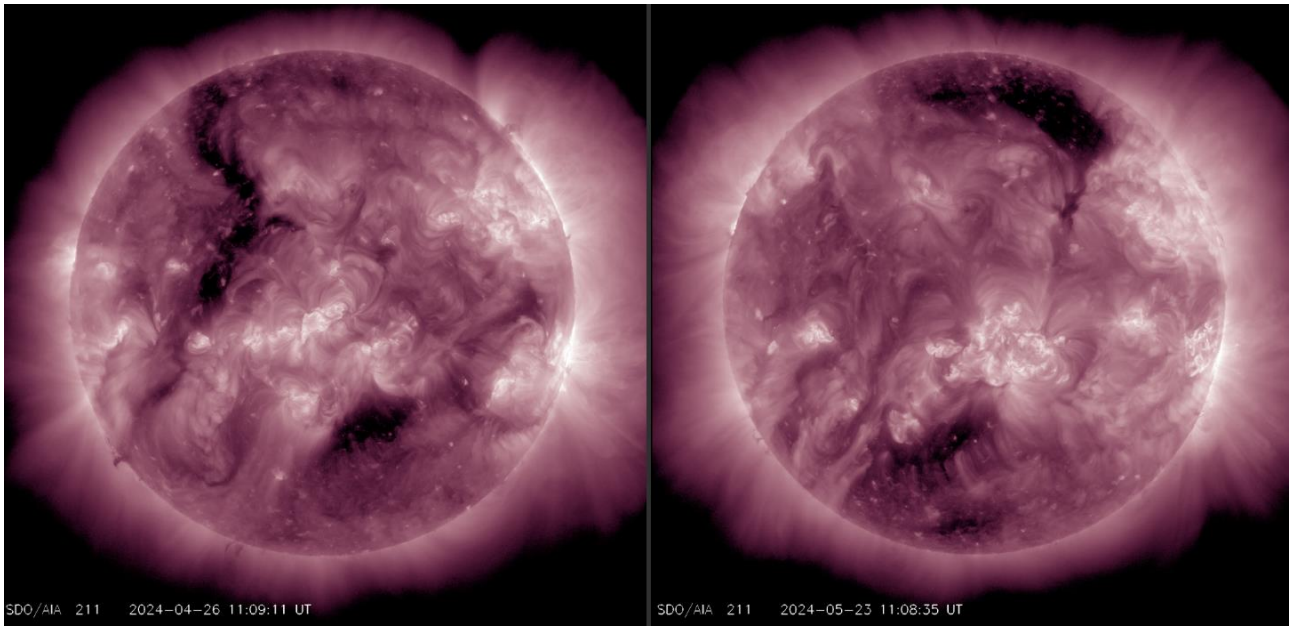
Figure 2: SDO AIA 211 imagery for the previous (26 April) and current rotation, showing the relative dissimilarity of the disc and lowering confidence in the geomagnetic fast wind forecast.



Radio Blackouts - X-Ray Flares:

The Sun is currently showing a strong hemispheric bias, with many of the more potent spots in the southern solar hemisphere. Potentially going some way to rectifying this trend will be the possible return of Ex-AR3663 and Ex-AR3666 over the northeastern limb from later Friday 24 May, however, it is uncertain how much of these regions have survived their transit across the far-side. A more assured far-sided survival from recent halo CME evidence is Ex-AR3664, which is the large G5-producing sunspot region of 10-11 May. This is due to return just outside the current range of the forecast.

The bulk of current front-sided activity has emanated from AR3679 in the southwest, with a recent lesser contribution from Ex-AR3674 now fading from consideration. AR3679 should also pass onto the far side between the two UTC weekend days, with daily flare risk probably showing a gradual reduction overall, although this speed of this may be revised once any east limb returnees present for analysis. A rise in daily risks is then probable into the forthcoming new UTC working week as Ex-AR3664 arrives.

All considered, Moderate activity is likely to continue with further isolated M-class flares Likely, and with a Slight Chance of an isolated X-class flare.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	70	60	55	50
Very Active	R3 to R5 X Class	No	10	5	5	1

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Figure 3: SIDC ROB flare locations of C-class and above recorded at PROBA-2 up to 23/1130UTC. The partitioning is more evenly spread than at other occasions in the past weeks, but can be seen to be largely the product of AR3679 and Ex-AR3674.

Solar Radiation Storms - (High Energy Protons):

High energy proton flux carries a daily Slight Chance of breaching the S1 threshold, largely due to the present of AR3679 in the westernmost third of the disc, with a minor contribution from the now-departed Ex-AR3674. There has been no recent history of proton enhancements from any group, however the risk is still felt to peak into the start of the coming UTC weekend before beginning to abate as AR3679 crosses onto the far-side.

Far-sided CME halo-producing activity of the past UTC working week is perhaps related to ongoing activity in Ex-AR3664, however this too has failed to yield any proton response and does not contribute to the risks shown.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	20	20	20	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

At the time of writing there are no definitively Earth-bound CMEs to influence the electron forecast at GEO, and the main driver of geomagnetic activity and arising electron response is therefore the non-persistent CH39/-. Being a new feature, confidence in the ensuing fluence is lower than is typical, but it does benefit from a relatively unimpeded CME outlook.

All considered, there is a Slight Chance of eventual Active 24-hour integrated fluence resulting from the fast wind, although the portion of CH39/- near the solar equator appears weak and we are nearing the less potent part of the semi-annual cycle (i.e. we are relatively nearer the muted solstice rather than the equinoxes).

MOSWOC REFM is felt to offer a reasonable guide, but this is perhaps more by chance than a concrete signal given the lack of a clear predecessor to CH39/- for persistence.

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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